IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application of

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| Applicant(s) | : Burch et al. |
| Serial No. | : 10/623,674 |
| Appeal No. | : 2007-0704 |
| Filed | : July 21, 2003 |
| Title | : **HIGH-EFFICIENCY FUEL PROCESSOR VIA STEAM INTEGRATION FROM A WATER-COOLED STACK** |
| Docket No. | : GP-303298/GMC 0044 PA/40320.48 |
| Examiner | : Keith Walker |
| Art Unit | : 1745 |
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Sir:

<u>RESPONSE TO NOTICE OF NON-COMPLIANT APPEAL BRIEF</u>

This paper is being filed in response to the Notification of Non-Compliant Appeal Brief mailed May 2, 2007. In response to the Notification, applicants are re-submitting below the Summary of the Claims section, the Evidence Appendix, and the Related Proceedings Appendix.

## V. SUMMARY OF CLAIMED SUBJECT MATTER

Referring generally to Fig. 1, the present invention, as recited in the claims below, is directed to a fuel processor based fuel cell system 10.

According to independent claim 1 and as shown in Fig. 1, the fuel processor based fuel cell system 10 comprises a primary reactor 12 adapted to generate a gaseous reformate from feed inputs comprising steam, and a high temperature proton exchange membrane fuel cell (HT-PEMFC) stack 16 in fluid communication with the primary reactor 12. (*See also* page 6, ¶ [0016].) The HT-PEMFC stack 16 is adapted to receive the gaseous reformate for generating electrical power and to generate the steam needed for the primary reactor 12. (*Id.*) The fuel processor based fuel cell system 10 further comprises: a compressor 78 adapted to provide compressed air to the HT-PEMFC stack 16; anode and cathode exhaust condensers 50, 52 adapted to receive heat energy from a respective exhaust (56 and 57) of the HT-PEMFC 16 and to heat air used by the compressor 78; and a stack excess steam condenser 54, wherein the air is also used to condense a portion of the steam provided to the excess steam condenser 54 before being fed to the compressor 78. (*See also* ¶¶ [0024]-[0027]).

Claims 2-12, 15-18, 20, 29, and 30 depend from claim 1. According to claim 2, the feed inputs further comprise air, hydrogen-containing fuel, and combinations thereof. Referring to Fig. 1, claim 3 recites a fuel processor based fuel cell system 10 further comprising a water gas shift (WGS) reactor 14 in fluid communication between the primary reactor 12 and the HT-PEMFC stack 16, and a primary reactor heat exchanger 40 in fluid communication between the primary reactor 12 and the WGS reactor 14 to heat at least the steam before being used in the primary reactor 12 with heat energy from the gaseous reformate. (*See also* ¶[0020]) Claim 4 recites a fuel processor based fuel

cell system 10 further comprising a catalytic combustor 44 in fluid communication with a superheat heat exchanger 42 to heat at least the steam before being used in the primary reactor 12 with heat energy from the catalytic combustor 44. Claim 5 recites a fuel processor based fuel cell system further comprising a WGS reactor heat exchanger 46 provided in fluid communication between a WGS reactor 14 and the HT-PEMFC stack 16, wherein the WGS reactor heat exchanger 46 is adapted to heat the steam before being used in the primary reactor 12 with heat energy from the gaseous reformate.

According to claim 6, the primary reactor 12 is selected from the group consisting of an auto-thermal reactor and a steam reformer. (*See* also ¶ [0016]). Claim 7 recites that a portion of about two-thirds to about one-half of vaporized water in the steam is recondensed in the stack excess steam condenser 54 and recycled to the HT-PEMFC stack 16 for cooling needs. According to claim 8, a portion of about one-third to one-half of vaporized water in the steam is used in the primary reactor 12. Claim 9 recites a fuel processor based fuel cell system 10 further comprising a catalytic combustor 44. Claim 9 further recites that excess hydrogen unconsumed by the HT-PEMFC stack 16 in a catalyst reaction using the gaseous reformate is fed into the catalytic combustor 44 to maintain a temperature required for producing the gaseous reformate in the primary reactor 12.

Claim 10 recites a fuel processor based fuel cell system 10 further comprising a catalytic combustor 44 in fluid communication with a combustor air preheat heat exchanger 60, which is adapted to receive heat energy from combustor exhaust 62 and to preheat air used in the catalytic combustor 44. Claim 11 recites a fuel processor based fuel cell system 10 further comprising anode and cathode exhaust liquid separators 64, 66 adapted to recover water from anode and cathode

exhausts 56, 57 from the HT-PEMFC stack 18. Claim 12 recites a fuel processor based fuel cell system 10 further comprising a stack coolant liquid separator 72 to separate liquid water from the steam exiting the HT-PEMFC stack 16. Claim 15 recites a fuel processor based fuel cell system 10 further comprising an anode exhaust preheat heat exchanger 58 receiving anode exhaust from the HT-PEMFC stack 16 and a bypass circuit 80 used to divert the gaseous reformate into the anode exhaust preheat heat exchanger 58 to provide greater heat input to the anode exhaust before sending the gaseous reformate to the HT-PEMFC stack 16. (*See also* ¶ [0028] ).

According to claim 16, the HT-PEMFC stack 16 has an anode stoichiometry from about 1.0 to about 1.3. Claim 17 recites that the primary reactor 12 uses a ratio of steam to fuel carbon (S:C) from about 2 to about 5. Claim 18 recites that the primary reactor 12 uses a ratio of atomic oxygen in air flow to carbon in fuel flow (O:C) from about 0.6 to about 1.5. Claim 20 recites a fuel processor based fuel cell system 10 further comprising a water/steam separator 86 to remove excess water contained in the gaseous reformate before being fed to the HT-PEMFC stack 16. (*See also* ¶[0037])

Claim 29 recites a fuel processor based fuel cell system 10 wherein the HT-PEMFC stack 16 has an anode stoichiometry in a preferred range of about 1.1 to about 1.2. Claim 30 recites that the primary reactor 12 uses a ratio of atomic oxygen in air flow to carbon in fuel flow (O:C) in a preferred range of about 0.75 to about 0.8.

Referring again to Fig. 1, independent claim 21 recites a fuel processor based fuel cell system 10 comprising a reactant stream comprising steam, a primary reactor 12 adapted to generate a gaseous reformate using the reactant stream, and a primary reactor heat exchanger 40 in fluid communication with the primary reactor 12 to preheat the reactant stream. Claim 21 also

recites a high temperature proton exchange membrane fuel cell (HT-PEMFC) stack 16 adapted to receive the gaseous reformate for generating electrical power, wherein the HT-PEMFC stack 16 is cooled by water and the steam is provided via water vaporization of the water in the HT-PEMFC stack 16. Claim 21 further recites a catalytic combustor 44, and a superheat heat exchanger 42 adapted to receive heat energy from the catalytic combustor 44 to superheat the reactant stream 32, wherein the superheated reactant stream is then combined with compressed air before being used in the primary reactor 12.

Claims 22 and 24-27 depend from claim 21. Claim 22 recites that the reactant stream further comprises a hydrogen-containing fuel, air, and combinations thereof. Claim 24 recites a fuel processor based fuel cell system 10 wherein the superheated reactant stream combined with compressed air is further combined with a hydrogen-containing fuel before being used in the primary reactor 12. (*See also* ¶ [0018]) Claim 25 recites a fuel processor based fuel cell system 10 further comprising a water gas shift (WGS) reactor 14 provided in fluid communication with the primary reactor 12, a WGS heat exchanger 46 in fluid communication with the WGS reactor 14, and an optional final CO-polishing stage 38 provided in fluid communication between the WGS heat exchanger 46 and the HT-PEMFC stack 16. Claim 27 recites a fuel processor based fuel cell system 10 further comprising a water injector 82 used to put water into the reactant stream prior to entering into the superheat heat exchanger 42 in order to provide the required steam for the primary reactor 12 at startup. (*See also* ¶ [0028])

Referring yet again to Fig. 1, independent claim 28 recites a fuel processor based fuel cell system 10 comprising a reactant stream comprising steam, a primary reactor 12 adapted to

generate a gaseous reformate using the feed inputs, and a high temperature proton exchange membrane fuel cell (HT-PEMFC) stack 16 adapted to receive the gaseous reformate for generating electrical power. The HT-PEMFC stack 16 is cooled by water and the steam is provided via water vaporization of the water in the HT-PEMFC stack 16. Claim 28 further recites a water gas shift (WGS) reactor 14 in fluid communication between the primary reactor and the HT-PEMFC stack 16, a primary reactor heat exchanger 40 situated between the primary reactor 12 and the WGS reactor 14 to preheat the reactant stream, a catalytic combustor 44, and a superheat heat exchanger 42 adapted to receive heat energy from the catalytic combustor to superheat the reactant stream 32. The superheated reactant stream is then combined with compressed air before being used in the primary reactor 12.

## EVIDENCE APPENDIX

None

## RELATED PROCEEDINGS APPENDIX

None

CONCLUSION

Applicants submit that the Appeal Brief is now in compliance with 37 CFR 41.37. Please direct any questions to the undersigned attorney.

Respectfully submitted,

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